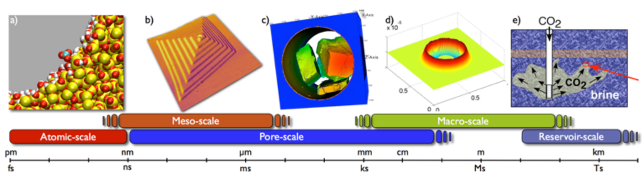
The Center's Mission

Enhance the performance and predictability of subsurface storage systems by understanding the molecular and nanoscale origins of CO_2 trapping processes, and developing computational tools to translate to larger-scale systems.

This DOE Energy Frontier Research Center (EFRC) is a collaborative effort led by Lawrence Berkeley National Laboratory (LBNL), the Oak Ridge National Laboratory (ORNL), Ohio State University, Princeton University, Purdue University, Stanford University, and Washington University in St. Louis. This Center is one of thirty-two U.S. Department of Energy (DOE) Energy Frontier Research Centers (EFRC).



Carbonate mineral precipitation at various scales. a) Atomic-scale simulation of carbonate adsorption onto a pore wall, b) single crystal carbonate mineral growth, c) Pore-scale reaction of calcite, d) CO2 bubble in porous media dissolving host mineral (blue) and precipitating carbonate minerals (red), and e) illustration of reservoir-scale processes.

The Center's Research

The research of the NCGC is divided into three Thrust Areas that address (1) the sealing effectiveness of fractured shales, (2) reservoir processes that control secondary trapping (capillary, dissolution and mineral trapping) and (3) developing the computational tools and insight necessary to model material properties and dynamics.

Center for Nanoscale Controls on Geologic CO_2

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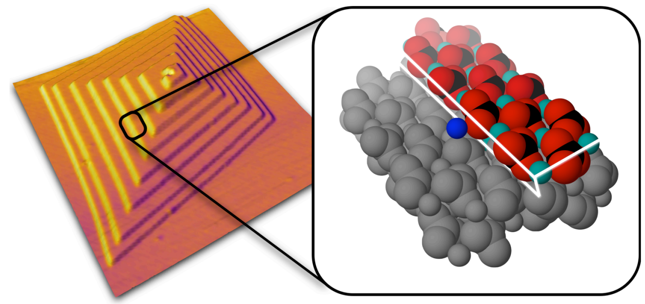
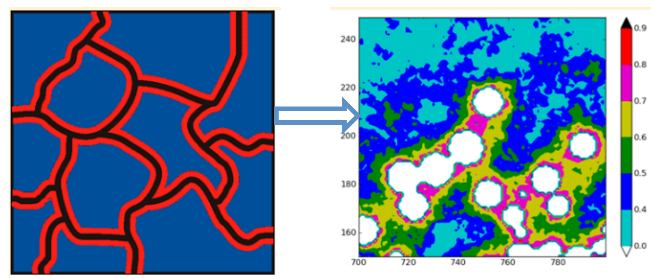


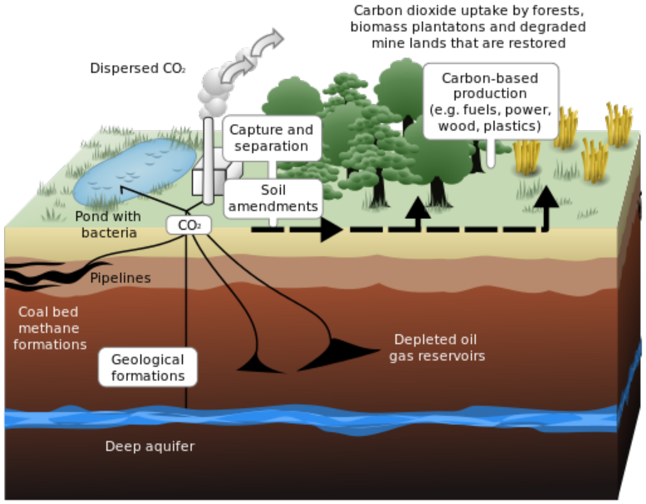
Molecular-to-nanoscale characterization and models



Calibration of computer simulations to experiments

A collaborative effort led by: BERKELEY LAB

Oak Ridge National Laboratory · The Ohio State University · Princeton University · Purdue University · Stanford · Washington University in St. Louis School of Engineering & Applied Science



CO_2 Capture & Storage

Capture and geologic storage of carbon dioxide is a critical energy technology for the 21st Century and is likely to be required to meet global goals for the reduction of carbon emissions to the atmosphere. However, real and perceived risks of underground CO_2 storage still provide barriers to public acceptance. The risks reflect uncertainties in fundamental knowledge of subsurface geological processes. Research done in this EFRC is directed at the scientific questions that result in uncertainties about how carbon dioxide will be trapped and held in the subsurface and in estimating the storage capacity of underground reservoir formations. The research, although entirely focused on subsurface carbon storage, is also more broadly applicable to subsurface science, since it addresses scientific issues that also arise in other energy contexts, including geothermal energy, nuclear waste isolation, and enhanced oil and gas recovery.

Project Structure

Thrust 1
Integrity of Fractured Shale

1. Influence of confinement on mineral stability
2. Clay mineral reactivity, swelling, and aggregation
3. Microstructure and mass fluxes across the fracture-matrix boundary
4. Resilience of fractured shale to flow of acidic CO_2-brine mictures

Thrust 3
Mesoscale Challenge

1. Mesoscale reaction rates: upscaling from molecular to pore scale
2. Mesoscale reactive transport: Theoretical and computational upscaling approaches

Thrust 2
Reservoir Trapping Processes

1. Physicochemical controls on residual trapping
2. Residual trapping at short times
3. Evolution of residually trapped CO_2 droplets and plumes
4. Mineral trapping, reaction rates, and evolution of the porous systems

NCGC Goals

1. Robust Models for nanoscale-to-mesoscale chemical-mechanical behavior of fractured shale.
2. Advanced models for the efficiency of capillary trapping and its effect on solution and mineral trapping.
3. Quantitative methods for estimating mineralogical trapping efficiency in reservoir rocks.
4. Theory, experimental data, and computational tools to allow nanoscale chemical effects to be translated to mesoscale properties and ultimately to continuum scale model equations and parameters.

Knowledge Gaps Addressed by NCGC Research

1. The origin and evolution of wetting properties of complex, reactive fluids in contact with common minerals encountered in carbon storage
2. Reactivity between fluids and minerals in nanoporous to macroporous rocks
3. Long term-evolution of capillary-trapped CO_2
4. The response of fractured shale to intrusion of CO_2-containing mixed fluids
5. Theory and computational tools that allow the large scale and long-timescale evolution of fluid-rock systems to be simulated such that they reflect the nanoscale and mesoscale properties of geological materials at far-from-equilibrium conditions.